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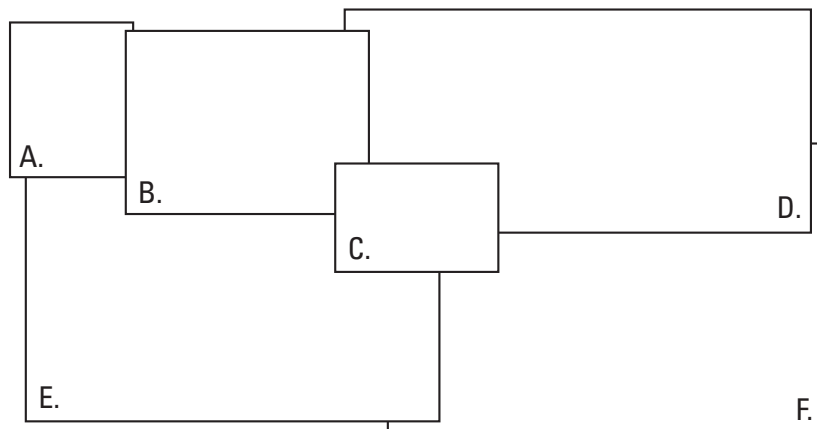


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USGS/NOAA Workshop on Mycobacteriosis in Striped Bass, May 7-10, 2006, Annapolis, Maryland



USGS Scientific Investigations Report 2006-5214
NOAA Technical Memorandum NOS NCCOS 41



A. U.S. Fish and Wildlife Service biologist weighing Chesapeake Bay striped bass exhibiting skin lesions. Photo by Christine L. Densmore, U.S. Geological Survey

B. Stained tissue section taken from the spleen of a Chesapeake Bay striped bass exhibiting granulomatous lesions associated with a mycobacterial infection. Photo by David Gauthier, Virginia Institute of Marine Science

C. Chesapeake Bay striped bass exhibiting emaciation and skin lesions consistent with mycobacteriosis. Photo by Mark Matsche, Maryland Department of Natural Resources

D. Collection of blood sample from striped bass harvested from the Nanticoke River, Maryland, in November 2002. Photo by Mark Matsche, Maryland Department of Natural Resources

E. U.S. Geological Survey field crew processing striped bass as part of a mycobacteriosis survey conducted in the tidal portions of Chesapeake Bay rivers during 2002 and 2003. Photo by Mark Matsche, Maryland Department of Natural Resources

F. Live well transport and landing of striped bass by U.S. Fish and Wildlife personnel. Photo by Mark Matsche, Maryland Department of Natural Resources

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Edited By Christopher A. Ottinger and John M. Jacobs

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condition factor and larger fish may have a greater probability of being infected (Overton et al. 2003, Rhodes et al. 2004). Although multiple *Mycobacterium* spp. were infecting the striped bass sampled, *Mycobacterium shottsii* was the most prominent species.

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Epizootiology of mycobacteriosis in Chesapeake Bay striped bass (*Morone saxatilis*): Large-scale field survey.

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Striped bass in Virginia and Maryland waters of Chesapeake Bay are experiencing an ongoing epizootic of mycobacteriosis. Visceral disease prevalence exceeding 50% has been reported in several locations by various authors, and skin lesion prevalence exceeding 30% has been observed. The high prevalence of skin lesions observed in Chesapeake Bay striped bass is unusual and has not, to our knowledge, been reported previously in wild fishes. It is alarming, as it may indicate that fish are progressing from chronic, covert infection to active, lethal disease. We have, however, observed putative healing lesions, so the prognosis of striped bass with skin lesions is unclear.

Various surveys continue to report high prevalence of mycobacterial disease in Chesapeake Bay striped bass; however, the overall picture regarding the scope and severity of the current epizootic remains unclear. The widespread nature of this epizootic, coupled with the highly migratory nature of striped bass, dictates that surveys with large spatial and temporal coverage must be employed to gain a better understanding of the disease on a population level. Further, surveys must be multi-year in nature in order to assess whether the epizootic is worsening, improving, or remaining constant over time.

Since 2003, we have been conducting a survey of mycobacteriosis in striped bass in Chesapeake Bay using the Chesapeake Bay Multispecies Monitoring and Assessment Program (ChesMMAAP) platform (<http://www.fisheries.vims.edu/chesmmap/>). The ChesMMAAP survey is intended to develop data on the distribution and feeding habits of fish species in Chesapeake Bay, and to apply these data to development of comprehensive multispecies management models. By virtue of its design and scale, this survey also provides an ideal sampling platform for studying disease in wild fish. Adult finfish are collected via balloon otter trawl five times per year over the entire Bay, ranging from the Bay mouth to the Susquehanna flats. Sampling is performed in 20-minute tows at 90 stations per cruise, with a stratified random design that covers all depths. Data collection on fish includes basic morphometrics (length, weight, eviscerated weight), otolith-determined age, and gut content analysis. In addition, comprehensive environmental data are collected at each station.

Mycobacterial disease status in striped bass is determined by histologic detection of granulomas, and severity index is calculated as granulomas/mm² of spleen.

From 2003–2005, disease status was determined for 1,645 fish. Ages ranged from 0 to 16, with a male/female ratio of ~3:2. In all 3 years of the survey, the first (late March) and last (late October) cruises of the year represented the majority of samples, but significant numbers of striped bass were also collected during summer (May–September) months.

Logistic regression analysis of 2003–2005 data indicates that risk of disease increases with age in both male and female fish, but per-year risk is significantly higher for male fish. Mycobacterial granulomas are observed in age-1 fish, indicating that sufficient risk factors are present within the Bay for expression of disease. The higher per-year disease risk of male fish may in part reflect their longer residence time in the Bay relative to females. This confounding influence of age and sex on prevalence must be taken into account when examining seasonal and regional apparent prevalence data. Regression models incorporating age, sex, cruise (season), region, and year indicate significant effects of all variables except year on disease status. This indicates that, taking other factors into account, the overall disease situation in the mainstem Bay was constant over the course of the study. Individual analyses of cruise and regional effects on disease status are complicated by several factors, and will be discussed in this presentation. Additionally, the fitting of various models to describe the observed apparent prevalence data will be described.

The relationship between mycobacterial disease status and fish condition has received considerable attention due to emaciation commonly observed in heavily diseased fish. The relationship between emaciation and disease in wild striped bass is a problem of causality, as equally plausible hypotheses can be presented where emaciation (e.g., due to lack of forage fish) leads to disease, and vice versa. The causal relationships involved here can only be determined by controlled laboratory studies. The association of disease with condition in the field, however, can provide useful information as to the overall health status of fish in varying stages of disease. Length/eviscerated weight regression analysis of fish collected via the ChesMMAP survey indicated no significant association between disease category and weight-at-length (ANCOVA, $p=0.073$). Some nonsignificant depression of weight-at-length was observed in severely diseased fish, and comparison of Clark's condition factor K ($K=\text{eviscerated weight}/\text{length}^3 \times 10^5$) between disease categories indicated significant reduction of condition in this group relative to no, minor, and moderate disease categories (ANOVA, $p<0.001$). These findings indicate that in fish collected from the mainstem Bay, disease had minor, if any, effects on condition. It should be noted, however, that very few emaciated fish were collected via the ChesMMAP survey, unlike the larger numbers of these fish typically seen in tributaries.

Mycobacteriosis in juvenile Atlantic menhaden.

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Concerns have been raised by reports of a high prevalence of mycobacterial infection in striped bass, *Morone saxatilis*, in the Chesapeake Bay. However, the problem may be much more extensive with infection among multiple species of Chesapeake Bay fishes, including Atlantic menhaden, *Brevoortia tyrannus*. Atlantic menhaden is a keystone species in the Bay and other mid-Atlantic estuaries. They play an important ecological role as plankton feeders and are a critical prey species for birds and larger predatory fish including striped bass and bluefish. Menhaden also represent the largest commercial fishery in the Chesapeake Bay. They are commonly used as bait for “chumming,” and are commercially harvested en masse (thousands of tons annually) for their protein. This protein is processed for use in animal feeds, as well as for their oil. Menhaden oil, which is rich in omega-3 fatty acids, is widely used in human and veterinary dietary supplements, and in cosmetics. The purpose of this study was to determine if juvenile Atlantic menhaden in the Chesapeake Bay are infected with mycobacteria. Juvenile menhaden were examined since they are the primary forage base for many Bay animals including striped bass.

An initial laboratory study was conducted with wild-caught juvenile Atlantic menhaden held under laboratory conditions. After 10 months, one fish was observed with a penetrating external ulcer, and *Mycobacterium fortuitum* complex and *Mycobacterium* spp. were recovered from the spleen and the ulcer of this fish, respectively. Subsequently, 20 additional fish were subsampled from this laboratory group to determine the prevalence of the infection. Full necropsies